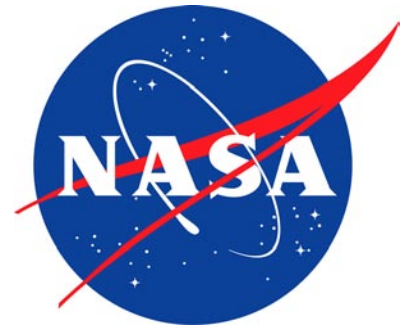
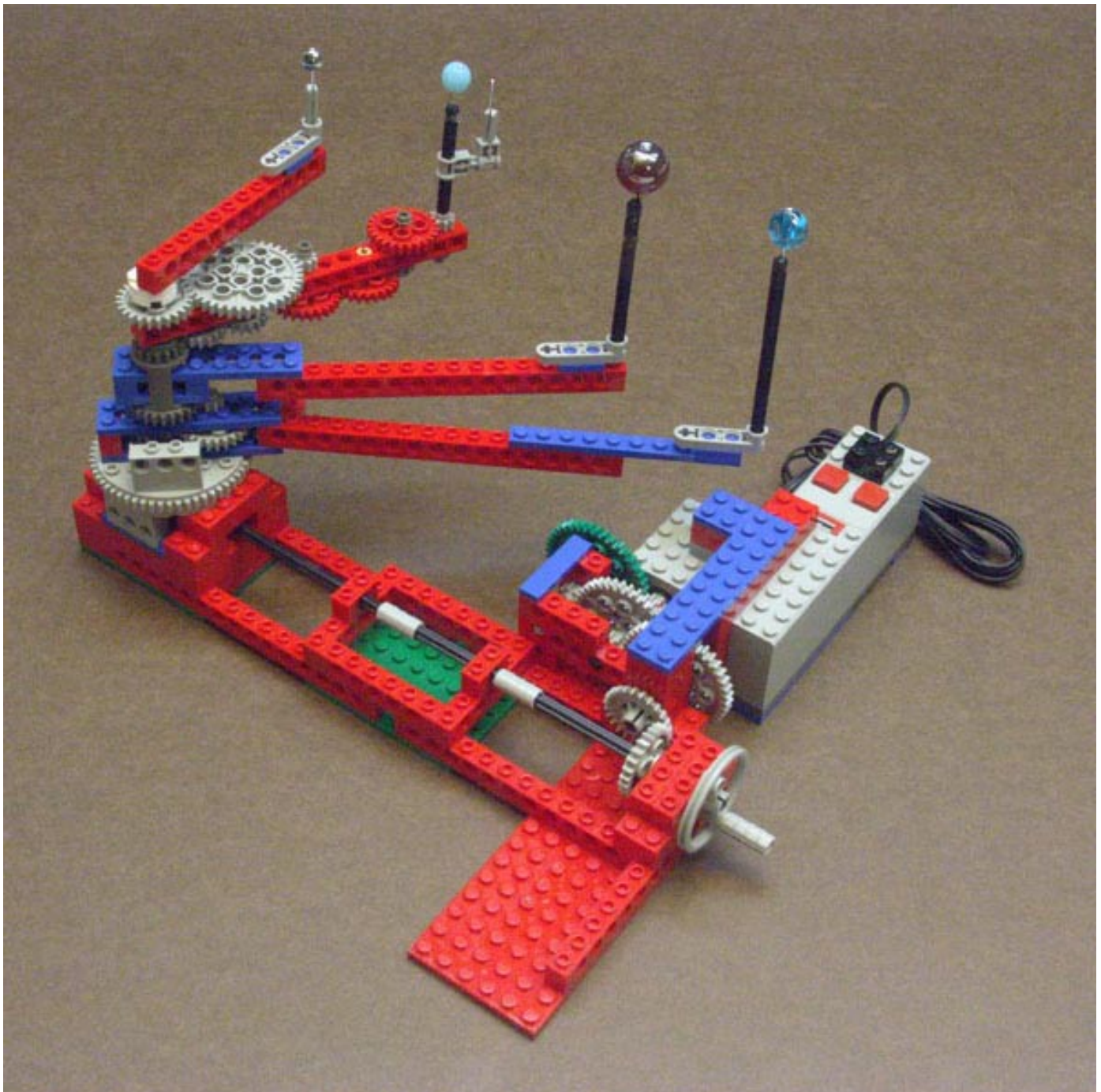


Kepler Planet Transit Demonstration



Demonstrates how the Kepler science team will use the Kepler satellite photometer to discover Earth-size planets around other stars by the transit method.



Kepler Planet Transit Demonstration

Version 2006—including a LEGO orrery with 4-planets+1moon

The Kepler Transit Demonstration illustrates how the Kepler science team will discover Earth-size planets around other stars by the transit method with the Kepler satellite photometer.

This document can be downloaded from the Kepler Education website at <http://kepler.nasa.gov/ed>

Components:

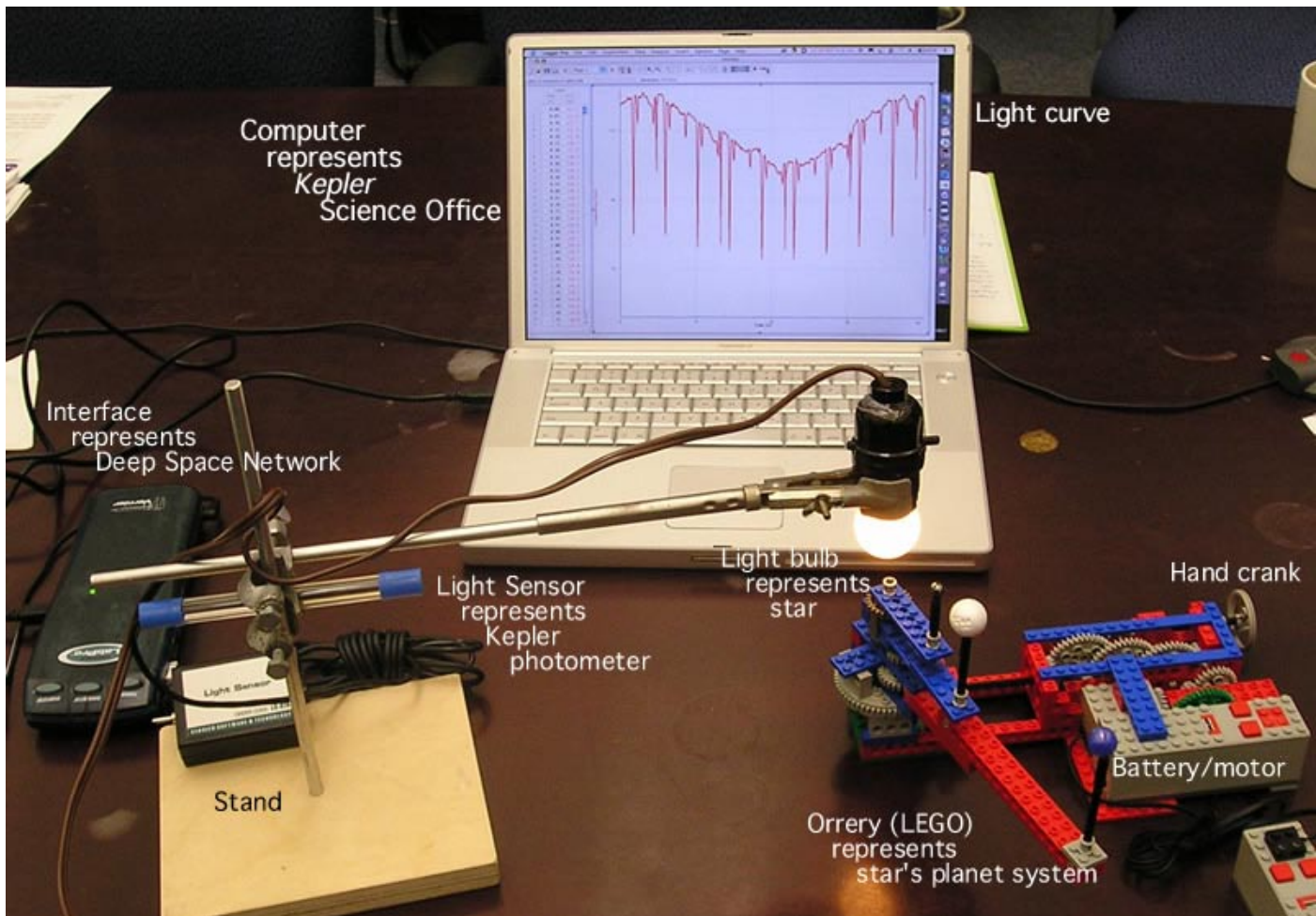
A LEGO-orrery model represents a planet system that can be set in motion with either a hand crank or electric motor.

A light bulb at the center of the orrery represents the star.

A light sensor represents the Kepler spacecraft photometer.

The light sensor is connected through an interface box (which represents NASA Deep Space Network) to...

A computer that represents the Kepler Science Office.



Sources of components:

From LEGO supply—these kits:

W979649 LEGO Technology Resource Set
(\$57 July, 2005)

W779876 LEGO Large Turntable (set of 2;
\$10, July, 2005)

W979615 LEGO 9V motor and battery
(optional; \$33, July, 2005)

see <http://www.legoeducationstore.com>

Computer-interfaced light sensor (e.g. from Vernier Software and Technology <http://www.vernier.com/>)

Interface: Go! Link \$59.00 (Sep 2004)

Light Sensor LS-BTA \$45.00 (Sep 2004)

Software: Logger *Pro* 3 [LP] \$149 (Sep
2004) for PC and Mac [you can also
download free demo version]

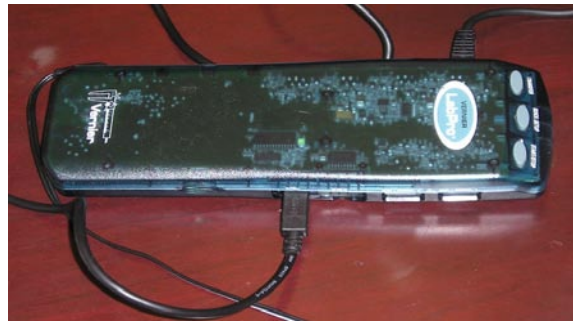
From a science company (e.g. Science Kit <http://www.sciencekit.com/>)

Metal Base (10cm x 15cm) with Rod
Size (8mm dia x 46mm long) \$8.95
WW6308001

Buret Clamp Plain jaws \$7.60
WW6107500 Plastic jaws \$8.75
WW6108000, adjustable, to hold light
sensor

Right Angle Clamp Holder - (6112000) \$7.95
(holds horizontal rod for clamp on light)

Clamp On Utility Light \$11.90
WW4639500



Vernier interface shown here is for 4 inputs. The
Go! Link unit is all that is needed for 1 input.



From a hardware store

Light bulb, 7.5W, medium standard base,
about 1.3" dia.

An extra metal rod as a horizontal support
for clamp on utility light

From a Bead or Craft Store

4 (or 5) beads from 3 to 20 mm in
diameter for planets.



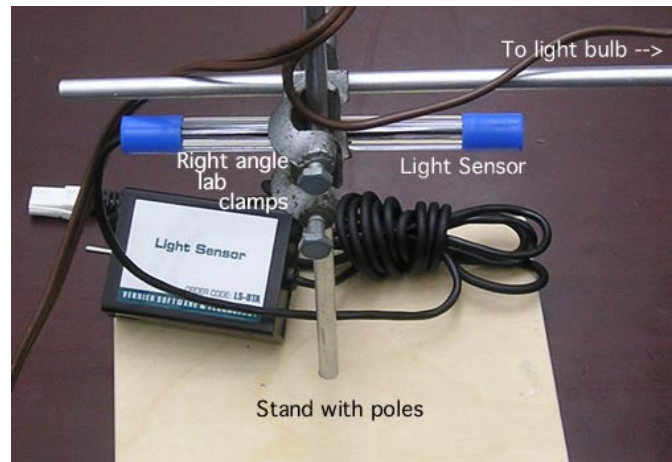
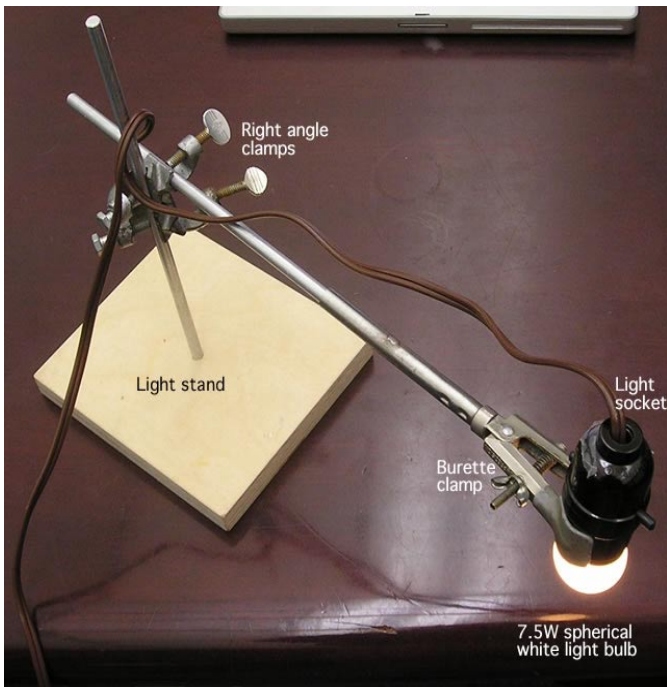
Reflector is not needed.



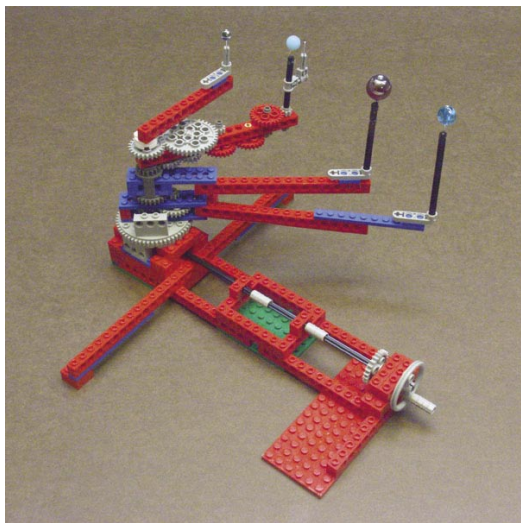
Burret Clamps

The stand to hold
the light and light
sensor and also be
assembled from
PVC tubing and
fittings.



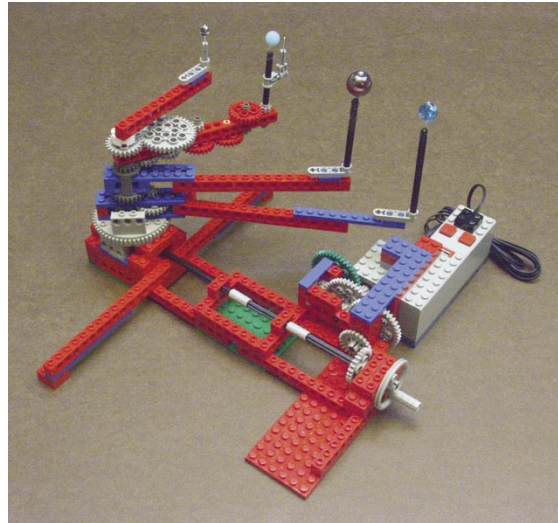


LEGO orrery—version 2006 (4-planet plus moon) assembly instructions



Hand-cranked

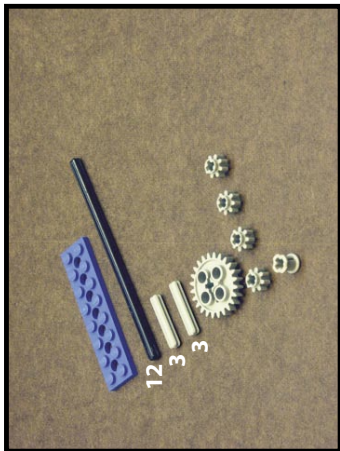
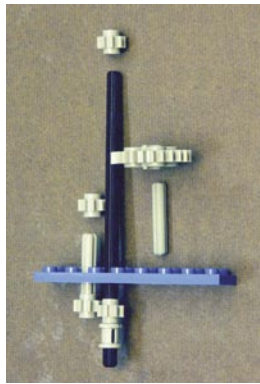
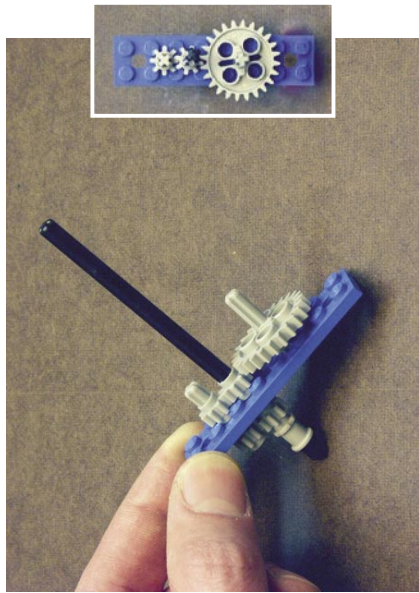
The following kits together contain enough parts to make two non-motorized orreries:
 W979649 LEGO Technology Resource Set
 W779876 LEGO Large Turntable (set of 2)



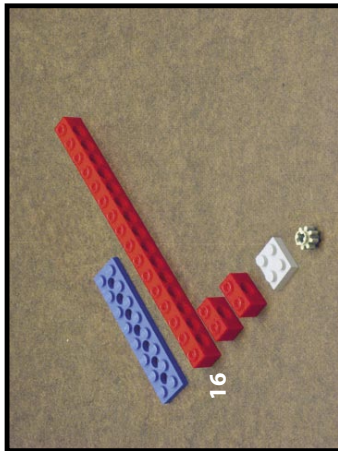
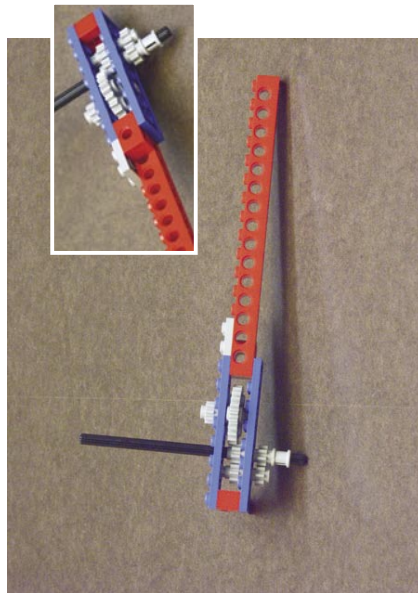
Motorized

Add one W979615 kit (LEGO 9V motor and battery box) plus three extra spur gears (W970620, package of 100) per orrery to make the motorized version.

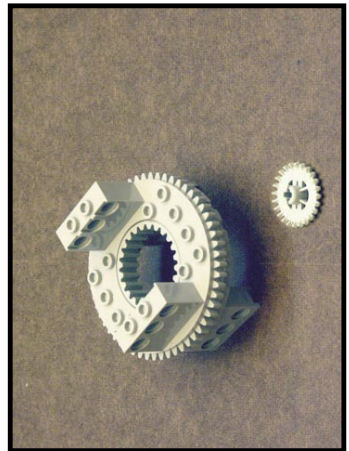
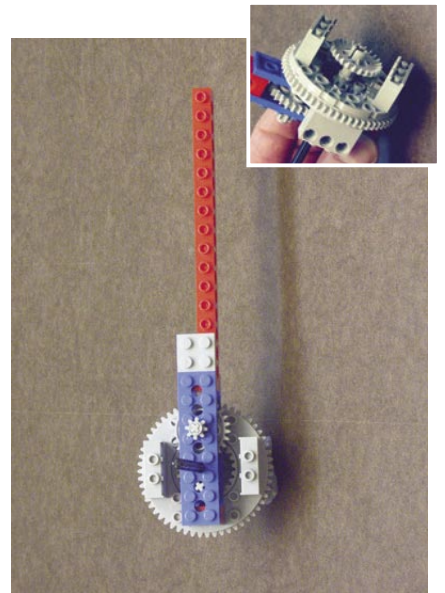
Kits available at <http://www.legoeducationstore.com/>



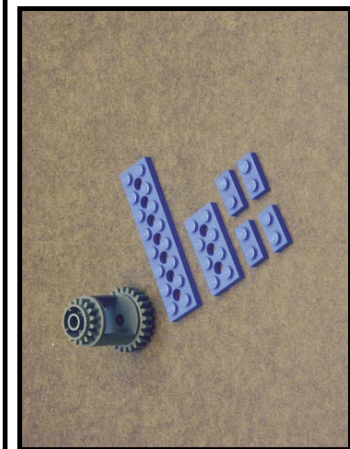
1



2



3



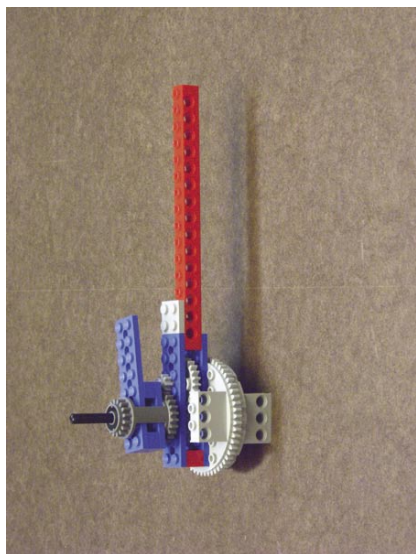
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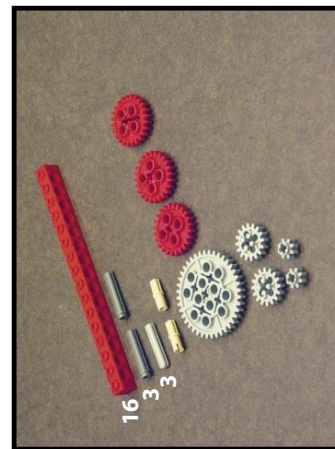
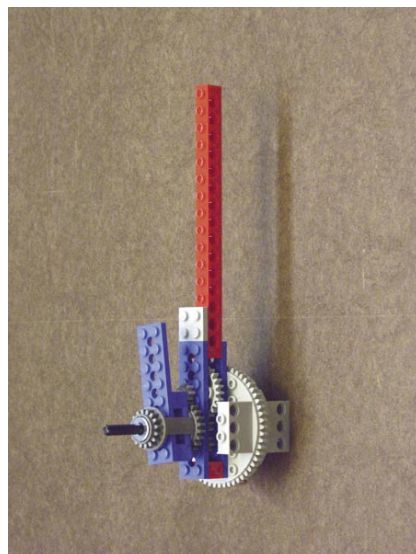
a.



b.



5



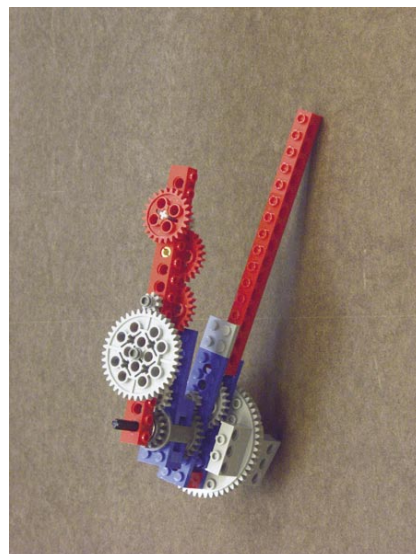
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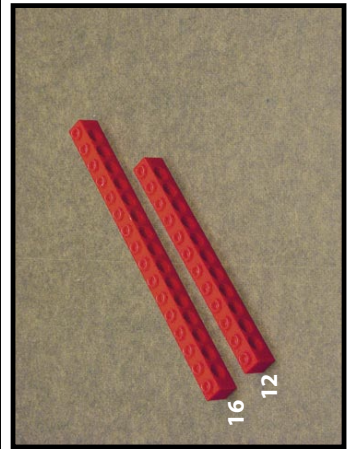
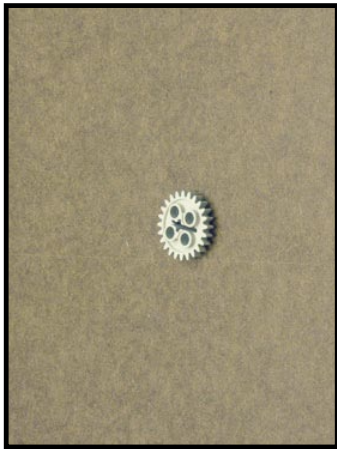
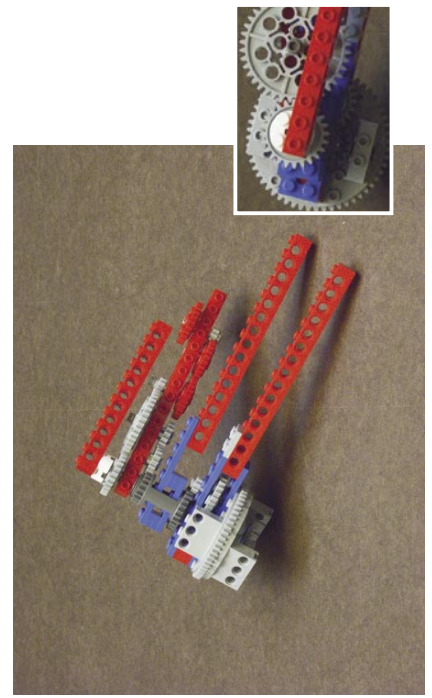
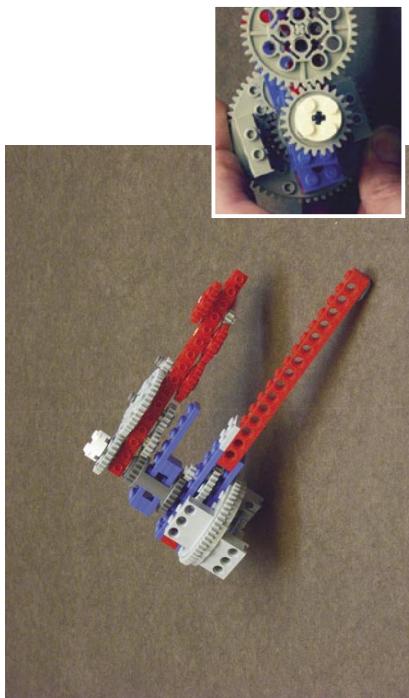
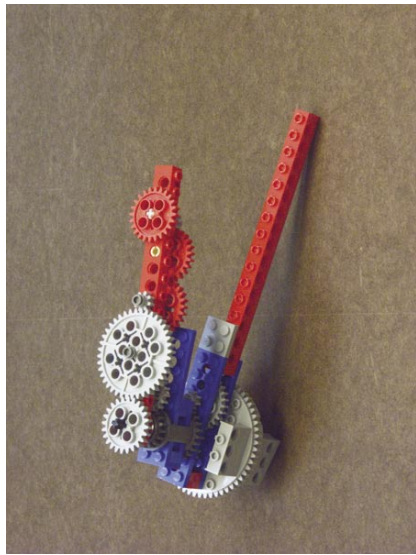


front view



bottom view

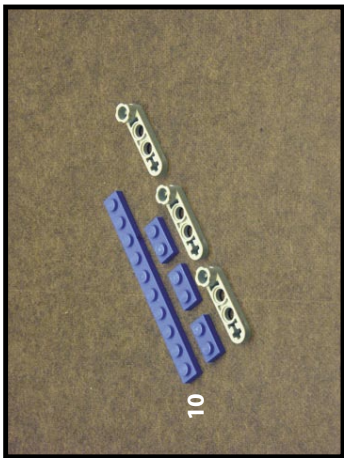
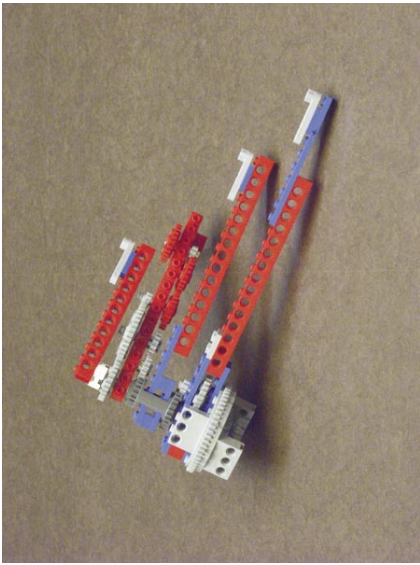




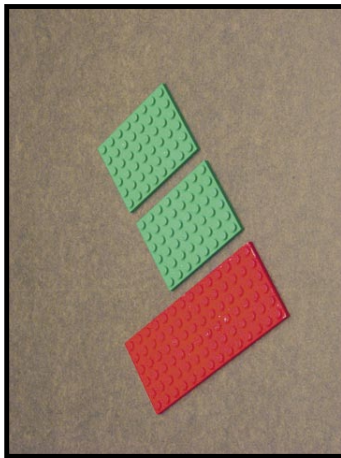
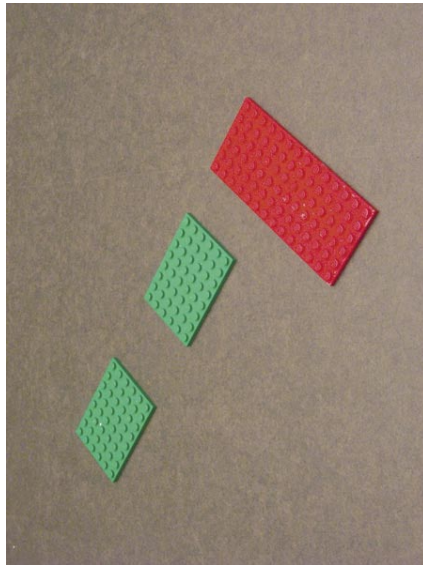
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8

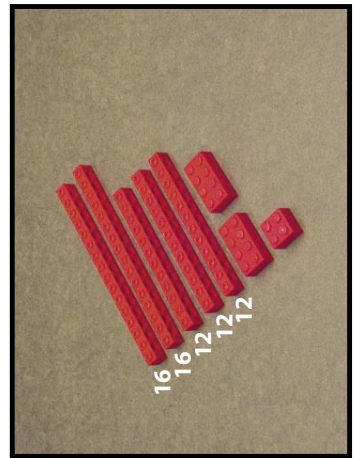
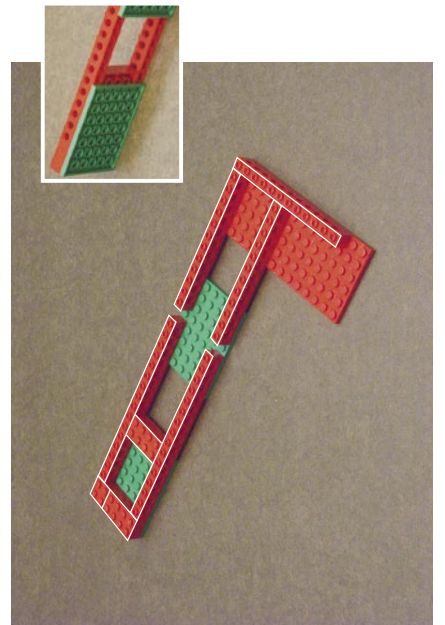
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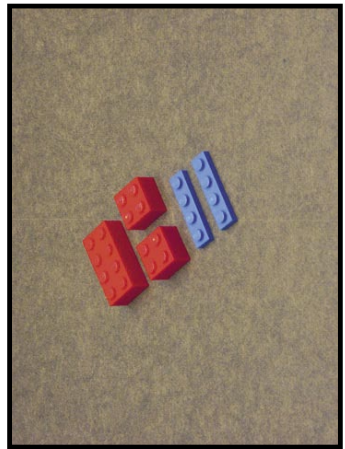
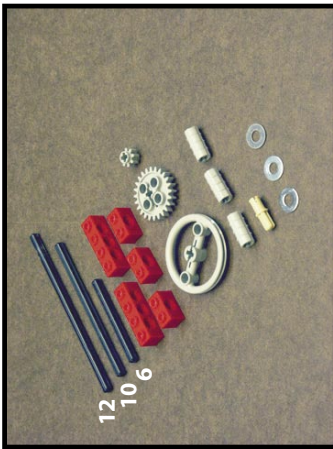
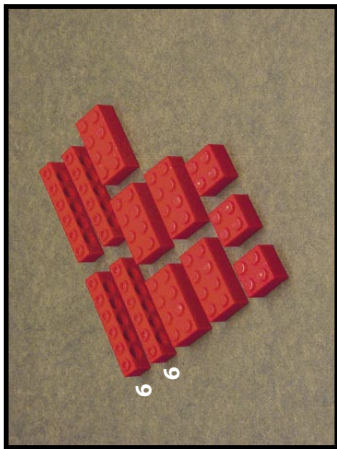
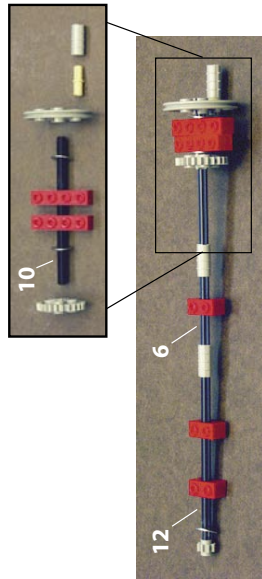
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11



12



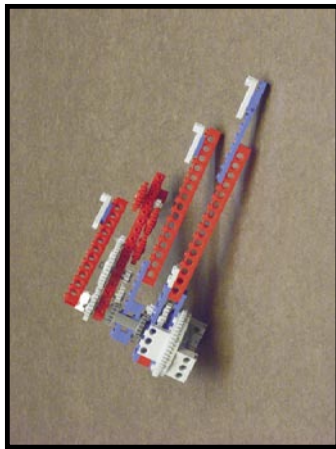
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14

15

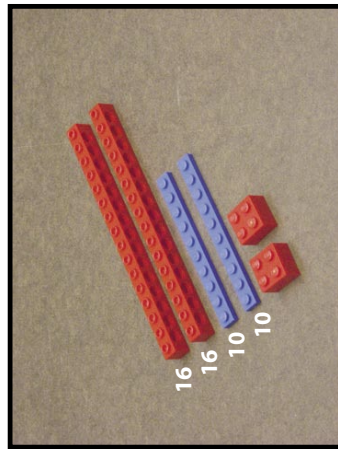


16

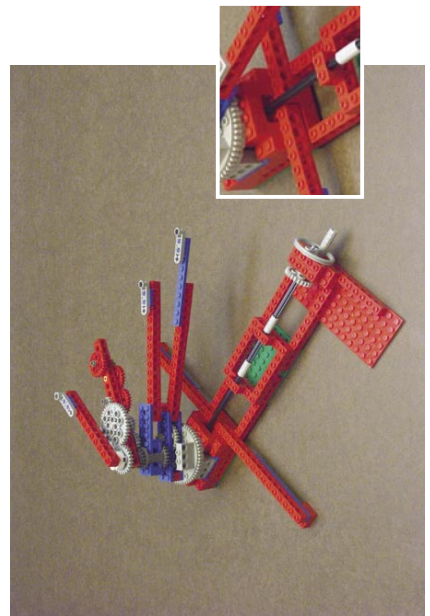
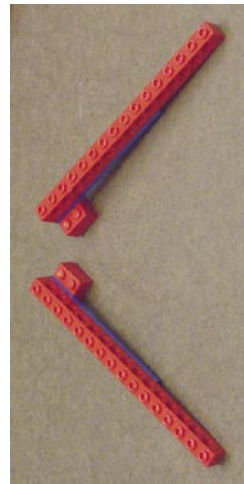


17

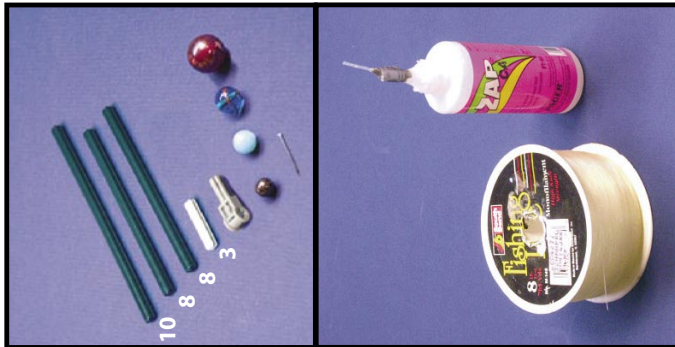
from step 10



18



19



To make planet rods:

- Notch LEGO rods.
- Glue beads to pins or nails.
- Tie pins/nails to LEGO rods using fishing line.
- Seal knots in fishing line with super glue (Note: Super glue does not stick to polyethylene LEGO rods; the glue adheres only to the pin and the fishing line.)



a.



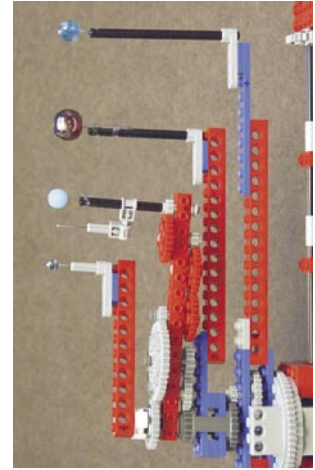
b.



c.



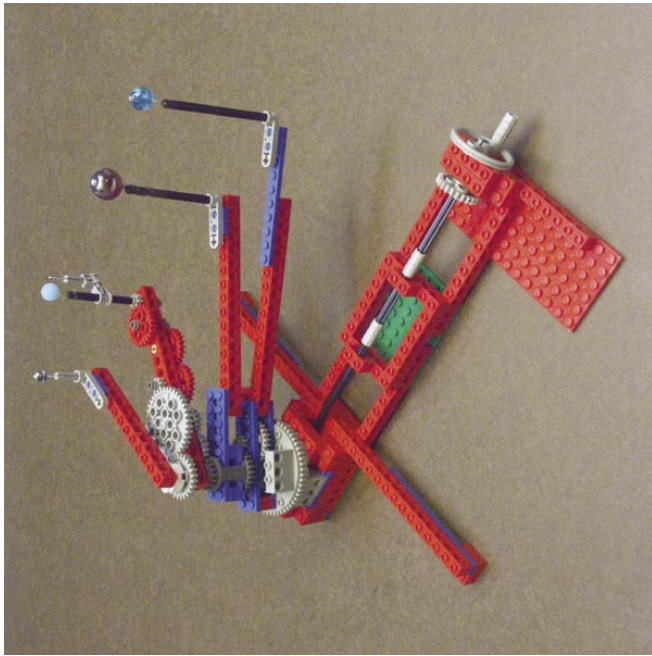
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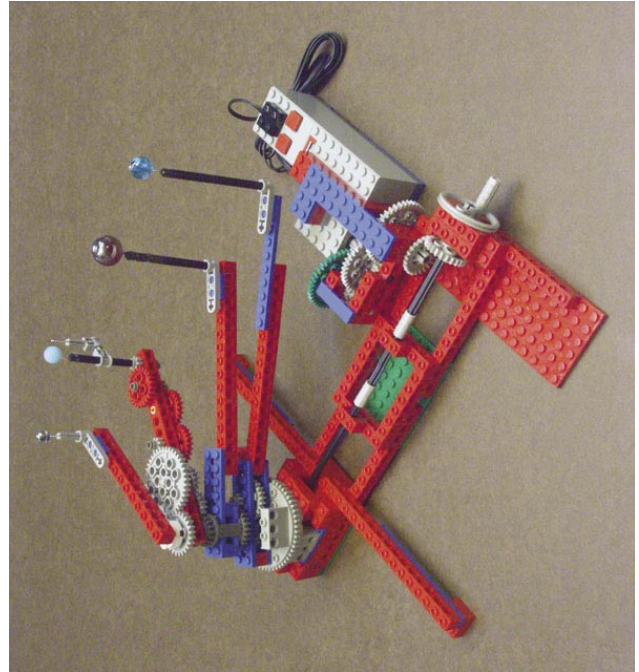
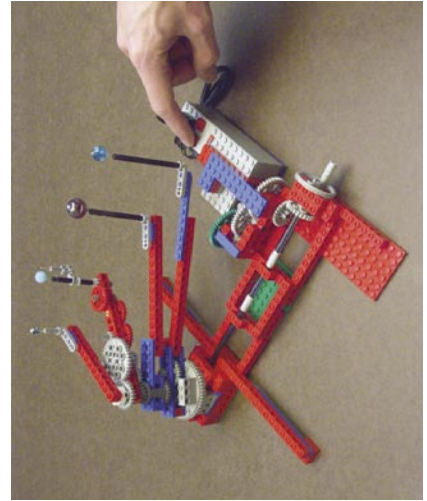
Orrery is now ready for manual operation:

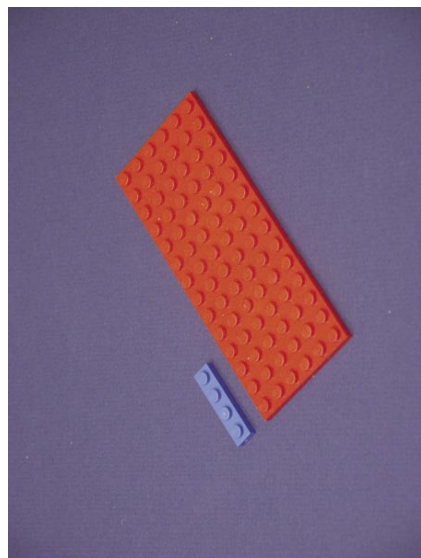
To make the model accurate in terms of Kepler's laws of planetary motion, adjust the lengths of the arms according to the formula below:

$$\frac{(\text{Orbit Period})^2}{(\text{Orbit Radius})^3} = \text{Constant}$$

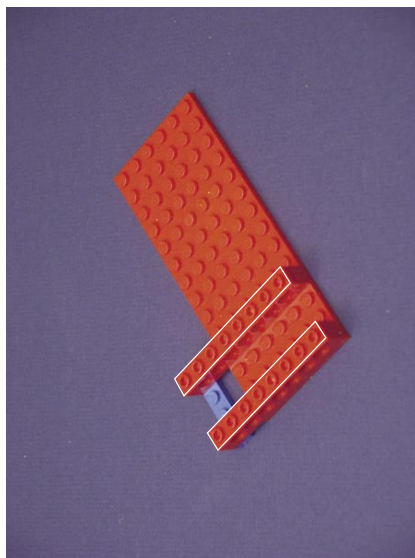


For motorized operation, build motor assembly as shown in steps 21–30

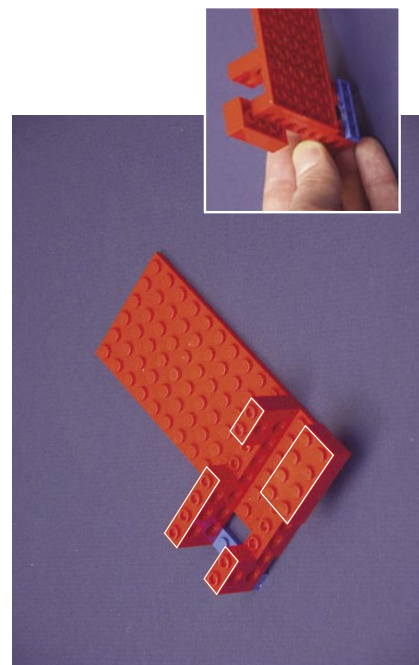




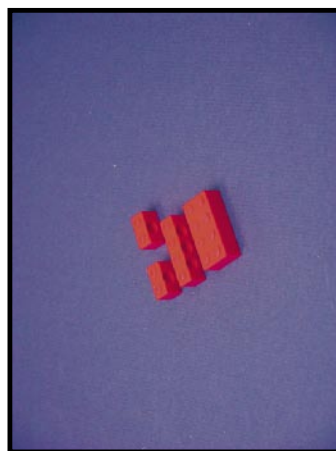
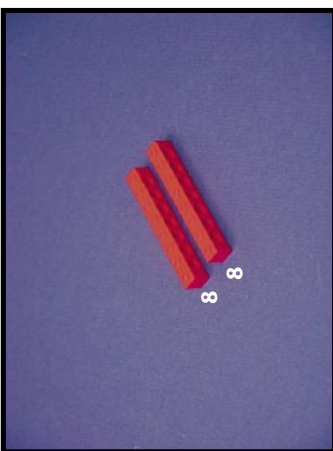
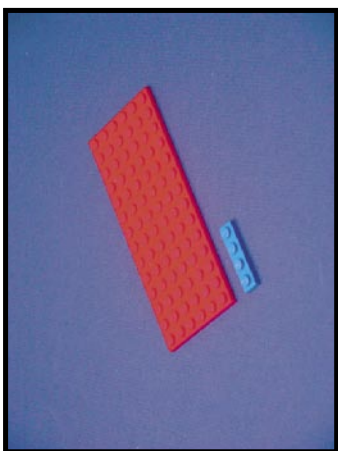
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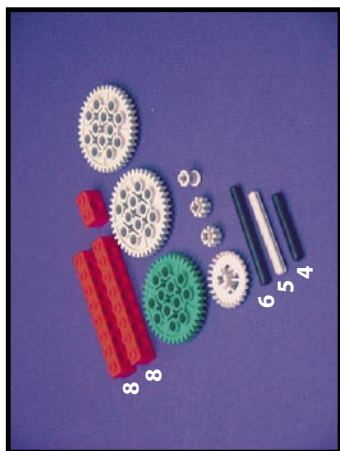
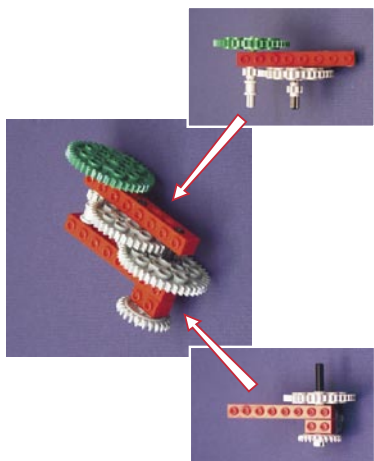


22

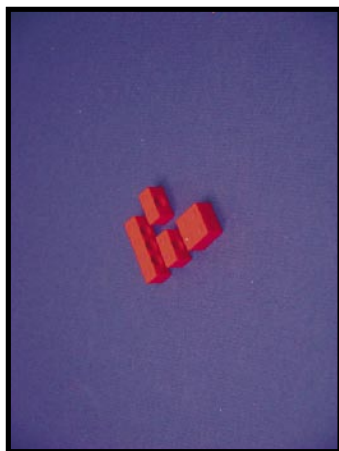


23

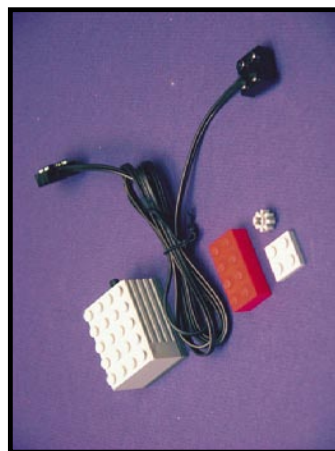
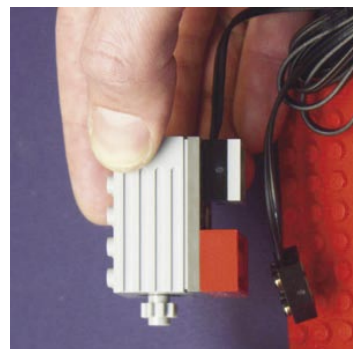




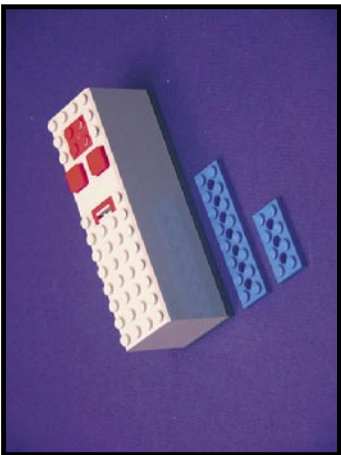
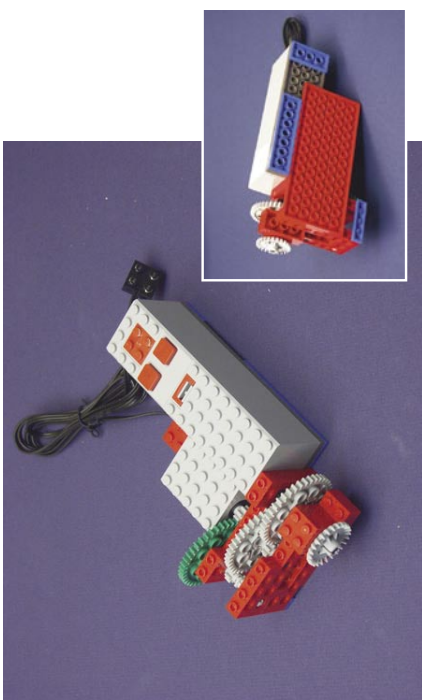
24



52



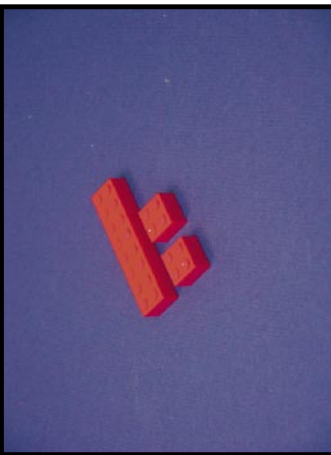
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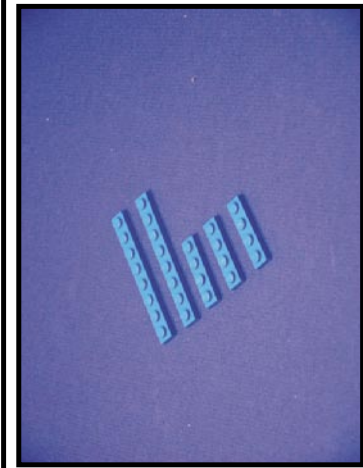
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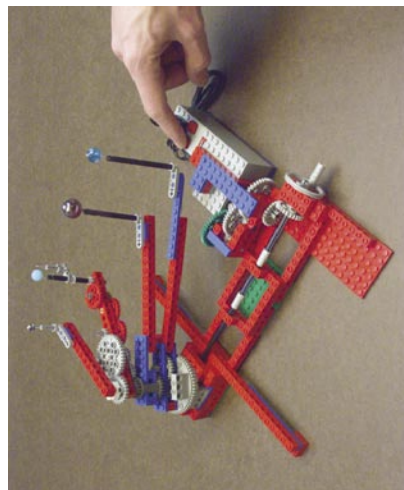
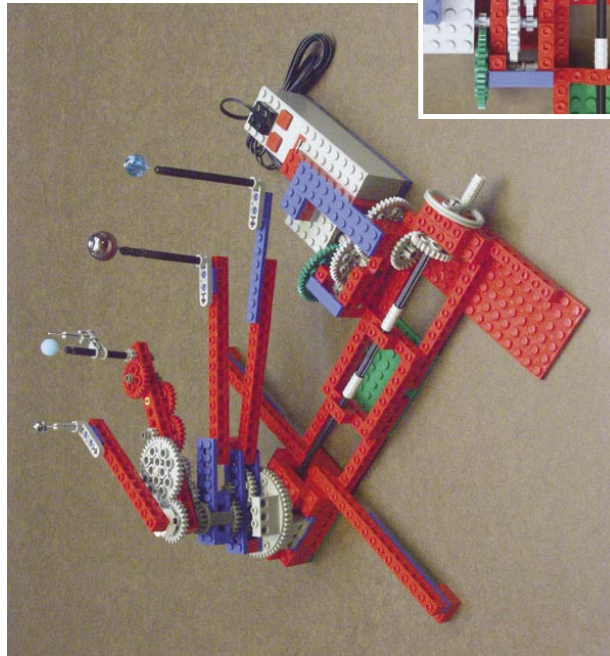
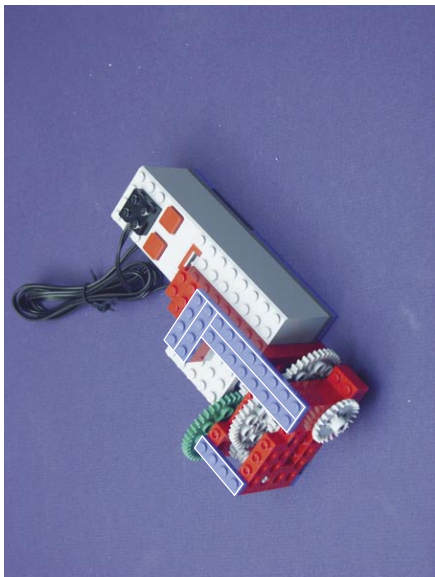
28



29



30



Attach motor assembly
as shown for motorized
operation: